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EOLE BALLOON SOLAR GENERATORS

J. Bezaudun, Editor

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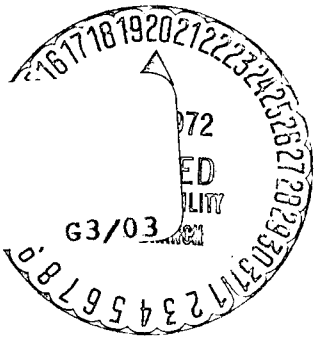

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EOLE BALLOON SOLAR GENERATORS

OBJECTIVE: Test report for the prototype R.T.C. solar generator.

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EOLE BALLOON SOLAR GENERATORS

No Author

ABSTRACT. The results of qualification tests carried out with EOLE balloon solar generator components are described. These include mechanical, electrical, environmental and launch simulation tests. The components were found to be acceptable.

1. Prototype Definition

/1*

In order to assure that the solar generators for the EOLE balloons conform to the specifications, a contract was signed with the R.T.C. for the procurement of:

- 5 experimental bread-boards
- 10 mechanical mockups
- 15 prototype generators

The following operations, described in Section 2, were carried out with the above:

- visual inspection
- electrical measurement
- mechanical tests
- environmental tests

described in Section 3.

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* Numbers in the margin indicate the pagination of the original foreign text.

2. Description of the Solar Generators

The photosensitive surface of the EOLE balloon solar generator consists of 120 thin silicon type N/P cells. These cells are divided into three modules mounted in paralell by means of an intermediate diode BAX 15.

Each consists of 40 cells connected in series and soldered to a printed circuit (Nema G.10 epoxy glass, thickness 100μ). Each cell is of type N/P. The resistance of the silicon is between 0.1 and 0.8 Ω cm. The dimensions of the elementary cell are 14.3 x 14.3 x 0.180 mm. The surface of the module is coated with a transparent SI 184 resin layer to protect the cells against humidity. The structure of the generator consists of two parts:

- a central cylindrical sleeve made of PPO (polyphenylene oxide) by means of which the generator can be mated with the batteries and the balloon.
- a polystyrene expanded support in the form of a right prism with a triangular cross section and molded around the sleeve.

The modules are glued along the faces of the prism by means of Dow Corning 96.052. silastene adhesive.

All the soldering work is done with Pb - Sn - Ag solder with a low melting point.

The cabling consists of Raychem type 44 wire . /2

JIFFY connectors are used to connect the battery and the gondola.

The weight summary is as follows:

Component	No. per solar generator	Weight per solar generator	Dispersion
Structure			
Sleeve and support	1	50,5	± 0,5
Printed circuits	3	8,7	± 1,2
Cells	120	10,2	± 0,4
Diodes	3	0,5	-
Cabling	3	3	-
Solder	120	0,5	-
Connectors	4	3	-
CI/support glue	3	6	± 1
Endocation* SI 184 glue	3	8,4	± 1
		Total weight P = 90,8 g	$\Delta p = \sqrt{\Sigma p_i^2}$ ≈ 1,9 g

* Probably a misprint.

The two attached diagrams show a side view of the adapted configuration. The solar generator is covered by a hood which has the purpose of protecting it against accidental shock.

The hood consists of two ethyl acetobutyrate shells manufactured by a thermoforming process (c = 2 mm).

The entire device is put into a sealed bag. The material used for this sack is a quadruple-layer film having the following composition:

- polyethylene
- aluminum
- polyethylene
- cellulose film

Small bags of a dehydrated substance are placed in this bag.

3. Test Reports /3

3.1. Visual Inspection

These controls were carried out for all generators and all the breadboards.

The defects which were found are following:

- bursting and separation of the cells
- notched edges of the cells
- superficial scratches
- copper observed (observed very rarely once or twice).

On a whole there were only a small number of minor defects. All the furnished items were accepted.

3.2. Electrical Measurements

Specifications:

The electrical specifications required of these prototypes are the following:

- illumination equivalent to 100 mW/cm^2 AM 1
- operating module current (V = 14.2 V before the blocking diode) should be larger or equal to 44 mA
- for any temperature between 0 and 50°C, this current should be greater than 42 mA.

Remarks:

For operation in series, the requirement will be less and we will take

$$30° C \quad I_{14,2} \geqslant 42 \text{ mA}$$

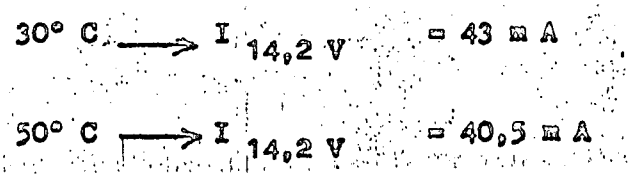
Description:

A module taken at random is calibrated at Mont-Louis and is used as a reference for controling the SPECTROLAB X 25 illumination simulator.

Results:

With the exception of one module, all generators conform to the specifications.

For the one module outside of the specifications, we found:



3.3 Mechanical Specifications /4

3.3.1 Shock test

Purpose: To test the strength of the protecting hood of the solar generator.

Description: A mockup was dropped from a height of 80 cm onto a cement floor. This was followed by six drops with impact at various orientations.

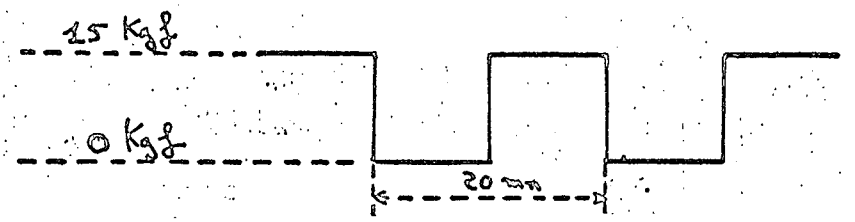
Results: Nothing to report for the mockup. In all cases, the sixth shock cracked the hood.

3.3.2. Traction test

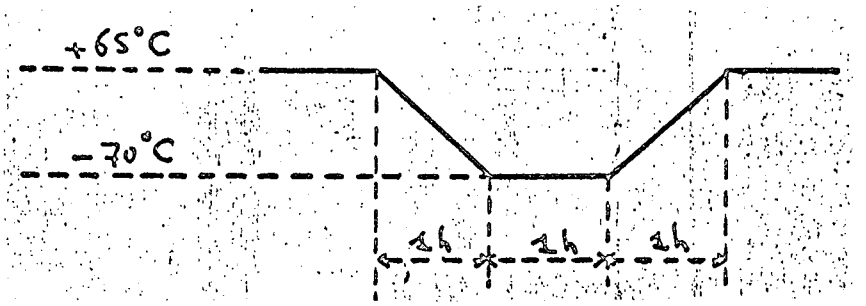
Purpose: To test the strength of the central sleeve adaptor.

Description: Traction tests carried out with a mechanical mockup which were adapted with blocking collars. The following cycles were carried out:

- 75 cycles in traction in the following mode at -70°C.



- 115 cycles of traction in the preceding mode at +65°C
- 40 temperature cycles in the following way at a constant traction of 15 Kgf



Results: Nothing to report.

3.3.3. Acceleration test

Purpose: To test the strength of the structure under acceleration.

Description: An acceleration of six g's was applied five times for four /5 minutes to a mechanical mockup. The mockup had four JIFFY's and cabling.

Results: Nothing to report.

3.3.4. Aviation safety

Purpose: The generators must have a mass per unit length of less than 5 g/m in order to satisfy aviation security standards.

Description: A glass casing is brought to the velocity of 280 m/sec for a vertically placed mockup.

Results: Nothing to report

The glass casing remained intact.

3.4 Environmental Specifications

3.4.1 Prolonged humidity test

Purpose: To test the hermiticity of the solar generator packing

Description: Humid storage for three months under the following environmental conditions.

- temperature 45°C
- relative humidity°: 95%
- atmospheric pressure

Results: Nothing to report.

3.4.2 Humidity test

Purpose: To test the behaviour of the solar generator with respect to humidity.

Description: Without the hermetic packing, the solar generator must conform to the electrical and mechanical specifications after three days of storage under the following conditions:

- temperature 30°C
- relative humidity 95%
- atmospheric pressure

Results: Nothing to report.

3.4.3 Ascent test

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Purpose: Study of the behaviour of the solar generator during its ascent.

Description: The generator is subjected to "ascent" sequence in which the pressure and the temperature vary simultaneously and linearly as a function of time for a total duration of one hour and within the following limits:

- pressure from 1013 mB to 200 mB
- temperature of +45°C to -70°C.

The decompression is accompanied by a slight decompression.

Results: Nothing to report.

3.4.4. Freezing test

Purpose: To study the behaviour of a solar generator during freezing cycles.

Description: The generator is brought to -20° at 200 mB pressure. Water vapor is introduced so that complete icing takes place. The generator is maintained frozen at -20°C for two hours and then the temperature is raised to +20°C.

Twelve cycles of this type were carried out.

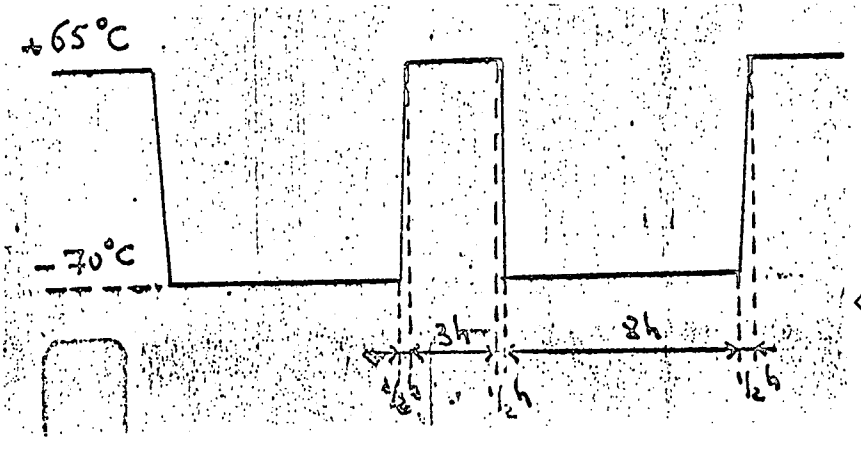
Results: Nothing to report. (The test was carried out at R.T.C. Caen. It is not done at the CNES).

3.4.5. Thermal cycling and thermal shocks

Purpose: To test the behaviour of the solar generator during thermal cycles.

Description: The thermal cycling is carried out at a pressure of 200 mB .

It consists of 90 cycles of the following type



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During the -70°C level, each of the three sides of each generator are subjected to a thermal shock as follows:

- entire generator is at -70°C. The three sides are heated by radiation heating so that their temperature increases to +65°C.

When this temperature is reached, the radiation is turned off and the sides are allowed to cool down, down to the ambient temperature of -70°C.

Results: The test carried out at CNES was done at atmospheric pressure. In other respects it is completely similar to the above description.

Breadboard test: The degradation is on the order of 1 mA at 14.2 V, but this degradation seems to come more from the dust and grease deposits on the breadboard due to the fact that a case having doubtful characteristics is used.

Test of the generator in use: Nothing to report at the present time.

4. Conclusion

We believe that the prototype generators furnished by the R.T.C. satisfy the imposed specifications in all respects.

Consequently, the mass production could pass immediately.

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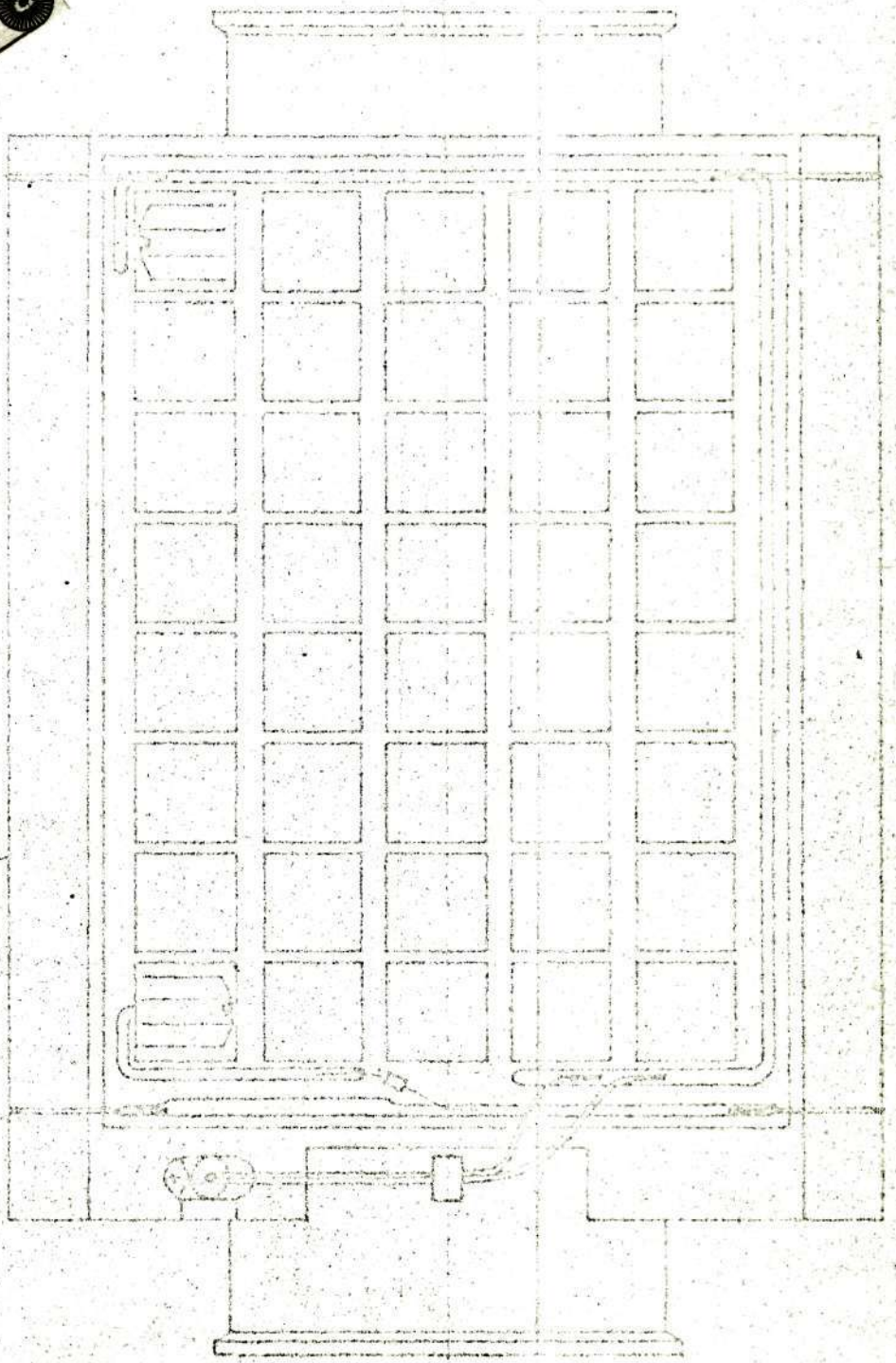

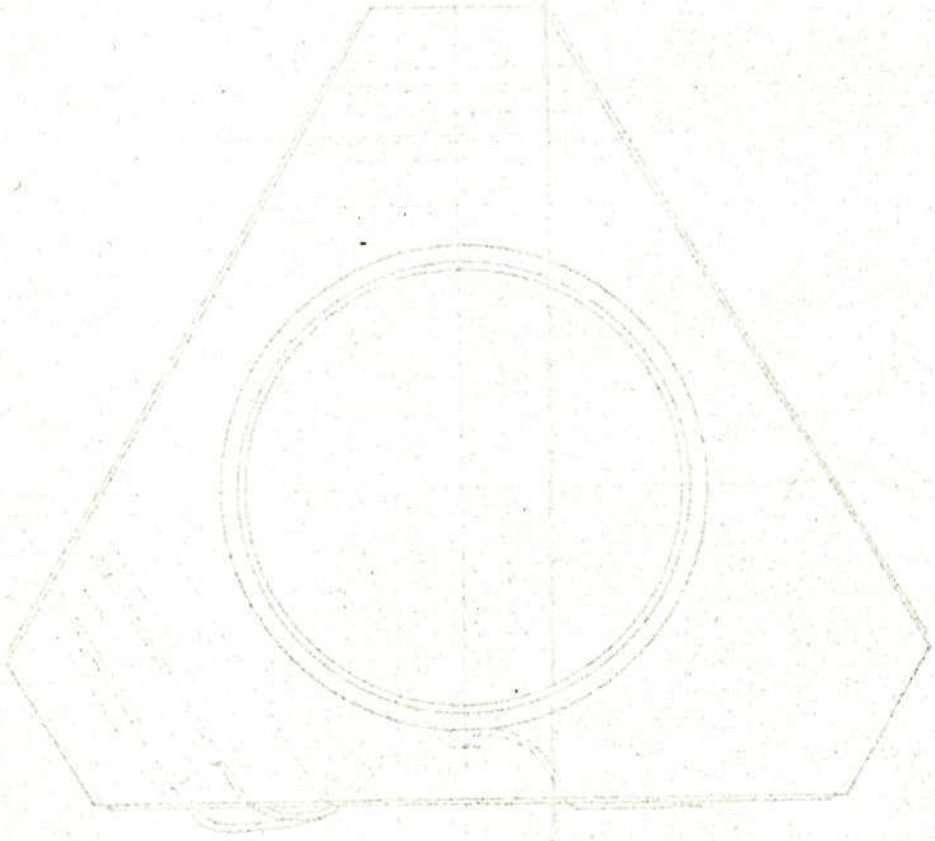

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